Wisconsin Department of
Natural Resources
Madison, WI 53707

REPORT OF THE TECHNICAL SUBCOMMITTEE ON DETERMINATION OF DREDGE MATERIAL SUITABILITY FOR IN-WATER DISPOSAL

November, 1985

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EXECUTIVE SUMMARY

It is well known that many pollutants, due to their chemical nature, become associated with aquatic sediments. Over many years of input, sediments may accumulate high concentrations of certain pollutants and become a major source of these pollutants and/or exert a toxic effect on certain aquatic biota. In many instances, from a chemical by chemical viewpoint, we know the concentration of the contaminants in a polluted sediment. What is largely unknown however, is what concentration of these chemicals in sediment either by themselves or in concert with others may cause significant biological harm. Therefore, what is needed is an evaluation scheme that not only measures concentrations of chemicals in sediment but also predicts the biological impacts of these contaminated sediments.

In view of our state of knowledge regarding impacts of contaminated sediments and the Department's present position on dredge disposal, the subcommittee felt that an approach aimed directly at guiding disposal options was necessary. To accomplish this, a comprehensive tiered testing scheme was designed to guide decision makers in evaluating dredge material. In a tier or hierarchal testing there is a series of tiers or steps progressing from the simple (i.e., analyzing existing data) to the complex (i.e., AMES mutagenicity testing). As one moves from simple to more complex tiers, more knowledge is gained on which to base a decision. Also, the completion of each progressing tier usually requires more expense, time, and effort. Generally, the decision to proceed or not from one tier to the next is based on the results from the completed tier and the objectives of the regulatory program (i.e., whether the goal is no degradation or environmental restoration). It must be realized that certain tiers of this evaluation scheme are presently being developed by our agency (see Appendix A) and are not available for use. Until these additional techniques are developed and adopted, the subcommittee has revised the existing chemical by chemical criteria (developed by EPA in 1977) and developed guidance criteria for in-water disposal.

Interim criteria were established through comparative analysis of background concentrations of selected chemicals in surficial sediments of Lake Michigan and Superior. Also, when establishing these new criteria, a policy of no degradation beyond what has already occurred was used. These new criteria, when compared to existing EPA criteria, are more lenient for heavy metals but more stringent for organic chemicals. Because of the more stringent criteria for organics, the subcommittee anticipates that few sediments from Great Lake inner harbor areas will be suitable for in-water disposal.

RECOMMENDATIONS

- The agency should adopt a tiered-testing concept similar to the one proposed by this subcommittee for evaluation of dredged material. Each tier should be designed to answer questions regarding disposal options.

- The agency should adopt the new interim criteria proposed by this subcommittee for use in evaluation of dredge material. These interim criteria should be replaced by national sediment criteria as they become available if the national criteria are acceptable.

- Elutriate testing should not be used in the evaluation of dredge material disposal options, however, the test should be used when assessing confined disposal options.

- For on the beach disposal, the agency should adopt the particle size criteria set forth by the subcommittee.

- In-water disposal, in the form of near-shore or beach nourishment may be allowed from a water quality standpoint if the sediment to be dredged meets the in-water criteria set forth by the subcommittee.

- For on the beach disposal, a Wisconsin Pollution Discharge Elimination System Permit should not be required.

INTRODUCTION

To more fully understand and appreciate the approach taken by this subcommittee a brief review of the current situation from both a policy and chemical-biological perspective are necessary. Also, it is important when reading this report, to keep in mind that dredge disposal for harbor maintenance is a subset of a much larger problem termed in-place pollution. Therefore, the planning, development, and guidance criteria proposed by this subcommittee will have impacts and utility beyond dredge disposal.

Dredging in Wisconsin: A Brief Historical Overview and the Current Situation

Concern over open water discharge of polluted dredge material in the Great Lakes began in the late 1960's. In 1968, the EPA Region V Office developed interim guidelines for defining "polluted" dredge material. Upon initiation of the diked disposal program in 1970, the Corps of Engineers (COE) asked the Governors of the Great Lakes states their views on continuing dredging with open water discharge, pending availability of containment facilities. Wisconsin's Governor at that time, Warren Knowles, opposed dumping dredged material in open water under any circumstances. Therefore the COE discontinued maintenance dredging of polluted material pending availability of disposal sites. By chance, during this period there were high lake levels, reducing the impact on navigation of discontinued maintenance.

During the early 1970's, concern mounted over the adverse effects of dredging and disposal operations in the Mississippi River. Legal suits on the dredging issue were filed by the State of Wisconsin against the COE. Eventually, in 1974, a joint organization - the Great River Environmental Action Team (GREAT) - was created to enhance coordinated decision-making regarding dredging practices on the Mississippi. Thus, awareness of the hazards of dredged material disposal had been sparked in the state, so that in 1973, when Wisconsin created its Wisconsin Pollutant Discharge Elimination System (WPDES), in Chapter 147 of the Statutes, "dredged spoil" was defined as a "pollutant." Because of definition, wastewaters generated during the disposition of dredged material require regulation by a state permit.

In July 1975, then Governor Patrick Lucey further articulated the state's position regarding open water disposal of dredged material. In a letter to the St. Paul District Office of the Corps of Engineers, the Governor requested that the unannounced disposal of dredge material from the Duluth harbor into the open water of Lake Superior be stopped. This letter clarified Wisconsin's prohibition of open water discharge of any dredge material into its adjacent waters. The Governor of Minnesota soon followed suit, and requested that the Corps cease open water disposal of dredged material in Lake Superior. Based on these requests (and threatened legal action), in-water disposal was ended in Wisconsin Great Lakes waters.

In March 1980, then Governor Dreyfus asked the Wisconsin Coastal Management Council to examine the dredging needs and problems of Wisconsin's Great Lakes Harbors. The Council directed its staff to develop a report on state and federal dredging policies and the status of dredging of Wisconsin Great Lakes Harbors. In October of 1980, the Council established a Dredging Task Force to further examine the issue of harbor maintenance dredging and state and federal regulatory policies. The Task Force was chaired by Wisconsin State Senator Daniel Theno. The Dredging Task Force met several times between January and June, 1981. During these meetings, the current regulatory framework for authorizing dredged material disposal and the economic climate in which Wisconsin's Great Lakes Harbors may find themselves were carefully discussed and evaluated.

At the same time, numerous proposals were and continue to be made by the current Federal Administration to charge a substantial portion of the cost of harbor maintenance dredging to state and local governments. Because of this substantial change in federal policy, there is now a greater concern at the state and local level with the need to hold the cost of harbor maintenance dredging within reasonable bounds without sacrificing environmental quality.

The Task Force concluded that the existing regulatory framework in Wisconsin appears to have sufficient flexibility so that a number of dredged material disposal options could be explored through demonstration projects. The demonstration project approach was desirable because information on the physical and biological impacts and the costs of these disposal options is generally lacking in Wisconsin.

The Council's recommendations were finalized on July 30, 1981, and were subsequently transmitted to Wisconsin Department of Natural Resources Secretary Besadny on August 28, 1981. Deputy Secretary Bruce Braun represented the Department on both the Dredging Task Force and the Coastal Management Council and concurred, on behalf of the Office of the Secretary, in the Council's recommendations. This concurrence means that the Department recognizes the value of studying certain disposal options so that more information is available on which to base regulatory decisions.

The first round of demonstration projects were intended to deal with the "beach nourishment" disposal option. The intent of beach nourishment is to make use of clean dredged material to replenish material lost from the beach to erosion and to help minimize future erosion. Two projects have been undertaken. The first of these is just east of the Duluth/Superior Harbor. The project placed "unpolluted" (by EPA definition) Nemadji River Sediments near shore in an area just up-drift from a groin field. Under natural conditions Nemadji River sediments were deposited as part of the Lake Superior beach. Dredging of the turning basin kept them from reaching the beach. Therefore, the shoreline adjacent to an abandoned landfill in this area was experiencing significant erosion and placement of material was expected to help compensate for this loss. The second demonstration project was at Kewaunee, Wisconsin. Clean material dredged from outside the breakwater was deposited along the shoreline south of the harbor to help build up the beach and compensate for past erosion losses which appear to have resulted from the interruption of littoral drift by the harbor breakwaters. Project reports will be available from Coastal Management, Department of Administration later this year.

In March 1984, a preliminary meeting was held to review the Department's dredge material policy.

At the meeting, the origins of Wisconsin's prohibition of in-water disposal; the pressures for changing it and the available results of beach nourishment demonstrations were presented. Bob Roden, Director of the Bureau of Water Regulation and Zoning, outlined three alternative dredging decision-making methods: project-by-project (current method); practice-by-practice (e.g. beach nourishment demonstrations) and harbor-by-harbor (e.g. GREAT effort on Mississippi River). Deputy Secretary, Bruce Braun, reminded the participants that other agencies as well as the legislature are feeling the same local pressure for more flexibility in harbor maintenance and development - if DNR does not make progress on the dredging issue, then the decision on in-water disposal may be taken out of our hands. Throughout the meeting, discussion revealed a wide range of opinions on the legal and scientific questions surrounding in-water disposal.

Objectives Of The Subcommittee

Subcommittees were set up to suggest technical and research needs and to detail policy options. The objectives of the technical subcommittee were:

1) Propose an evaluation scheme that would enable clean dredge material to be utilized in a beneficial manner.

2) Develop interim criteria through revision of those developed by EPA in 1968.

3) Determine suitable particle size distributions acceptable for in-water disposal.

4) Make recommendations on the form of open water disposal the state should initially allow.

5) Review other Region V state approaches to dredge disposal guidelines.

6) Evaluate existing waste leaching techniques.

Scope of the Problem from a Chemical and Biological Perspective

It is well known that many pollutants, due to their hydrophobic nature, will partition to the sediments of an aquatic environment. Over many years of anthropogenic input sediments may accumulate high concentrations of certain pollutants and become a major source of these pollutants and/or exert a toxic effect on certain aquatic biota. In many instances, from a chemical by chemical viewpoint, we know the concentration of the contaminants in a polluted sediment. For example, many of Wisconsin's larger rivers, especially those draining to the Great Lakes are known to contain elevated levels of polychlorinated biphenyls (PCBs), dioxins, furans, other aryl hydrocarbons, heavy metals and polycyclic aromatic hydrocarbons (PAHs). What is largely unknown, however, is what concentration of these chemicals in sediment either singly or in concert may cause significant biological harm. Therefore, what is needed is an evaluation scheme that not only measures concentrations of chemicals, but also predicts the biological impacts of contaminated sediments.

A PROPOSED TIERED TESTING APPROACH FOR DREDGING PROJECT EVALUATION AND ALTERNATIVE METHODOLOGIES FOR INTERIM CRITERIA DEVELOPMENT

Overview

In view of our state of knowledge regarding impacts of contaminated sediments and the Department's present position on dredge disposal the subcommittee felt that an approach aimed directly at guiding disposal options was necessary. To accomplish this a comprehensive tiered testing scheme was designed to guide decision-makers in choosing between three dredge disposal options; in-water, in-water confined, and upland disposal. It should be realized that certain tiers of this evaluation scheme are presently being developed by our agency (See Appendix A) and at present are not available for use. Until these additional techniques are developed the subcommittee has revised the existing chemical by chemical criteria (developed by EPA in 1977) to more accurately assess available disposal options.

Rationale

A tiered testing approach was formulated for a variety of reasons. The major advantage is that it lays out tests to be performed and requirements to be met for in-water disposal. It allows incorporation of our existing criteria into the decision process. Also, it will allow a smooth transition from our present guidelines to the more sophisticated tiered bioassessment approach. Furthermore, this approach will allow for the proper evaluation and management of dredged material using techniques that will be designed specifically for the unique characteristics of dredged material.

Proposed Tiers

Outlined below is a proposed tiered testing scheme. Each tier has certain requirements, and are designed so that each successive tier builds on knowledge gained from completing an earlier tier. It should be noted that the details of this approach are being formulated in a three year effort under Section 22 planning assistance in conjunction with the Corps of Engineers. (See Appendix A)

Tier I - Initial Assessment

This tier is designed to require investigators to evaluate existing information. Most contaminated sediment sites have some existing data and/or historical information which can provide valuable insight regarding the present degree of contamination.

Tier II - Bulk Chemistry Analysis/Acute Toxicity Testing

If little or no information is available through Tier I, at a minimum, a bulk chemistry analysis of the sediment is required. When acute toxicity testing becomes available this will also be mandatory for Tier II data collection information.

Tier III - Life Cycle Tests (Reproduction and Growth) Bioaccumulation

As these tests become available they will be required for sediments proposed to be disposed of in open water and may be required for other disposal options.

Tier IV - Other Bioassessment Techniques

As these tests move from the developmental stage to practical use they will be a final step for open water disposal. Alternately, some of these tests may be moved to lower tiers and used as simple cost-effective toxicity screening techniques.

Development of Interim Criteria

Until the methodology for Tier III and IV are more fully developed and adopted as tests by the DNR, the agency will have to rely on bulk chemical analysis for dredge disposal guidelines. Existing chemical guidelines presently used by our agency are not adequate to meet our developing policy goals. Therefore, the subcommittee was charged with developing revised interim criteria.

Due to uncertainty associated with ecologically sound management of contaminated sediments, a large amount of work addressing this issue is presently being undertaken. In the development of national sediment criteria, four approaches were recently reviewed by a private contractor (JRB Associates) for EPA. The approaches evaluated by the contractor are discussed below. These approaches were also considered by the subcommittee when addressing the issue of interim criteria. The approaches include 1) background approach, 2) water quality criteria approach, 3) equilibrium partitioning approaches, and 4) bioassay approach.

ALTERNATIVE METHODOLOGIES FOR INTERIM CRITERIA DEVELOPMENT

BACKGROUND APPROACH

Definition

Criteria are established with reference to measured contaminant concentrations in sediment from a specified target area, in which contamination is considered to be very low or at least within acceptable limits.

Methodology

The background approach avoids the difficult, and as yet unanswerable, toxicological questions inherent in all other approaches to sediment criteria. Rather than attempting to establish an environmentally safe contaminant threshold, the approach simply establishes the criteria in relation to contaminant concentrations in a reference area where contamination is at acceptable levels. The methodology of the background approach can vary considerably depending on the reference area used. In the most conservative application, the reference sediment could be collected by deep cores in an attempt to estimate pre-industrial contaminant levels. However, such an approach would not be workable since some enrichment of contaminants above pre-industrial levels is unavoidable. In addition, it would not provide adequate criteria for some of the synthetic organics that would be absent from pre-industrial sediments, except by vertical migration. A better, though still unsatisfactory, approach would be to use surface sediments from a relatively uncontaminated area as the reference sediment. This information would be valuable in comparing the magnitude of contamination elsewhere, however, as a criterion background levels derived from pristine areas would prove unnecessarily restrictive, because the environment may be capable of assimilating additional contamination without adverse effect.

In order to account for this additional assimilative capacity, it would be desirable to establish the criteria at some permissible level of enrichment above background. To determine this level of enrichment in a technically defensible fashion requires a substantial amount of toxicological information in order to establish the degree of enrichment that would be biologically acceptable. The establishment of a permissible enrichment above background would, in effect, then become a criterion in itself, in which case the original background level would become superfluous. Lacking the needed toxicological data, but recognizing the over-restrictive nature of criteria based on background levels in pristine areas, it might also be possible to establish an arbitrary level of enrichment, though this would raise serious doubts as to the legal and technical defensibility of such an approach.

Advantages

- Given the inadequate data available on toxicity of sediment-associated contaminants, some form of the background approach provides the only means currently available to establish interim chemical criteria for sediments.

- The field data necessary for application of the background approach are already available in many areas or can be obtained relatively easy.

Disadvantages

- Many forms of the background approach are of questionable legal and technical defensibility.

- Criteria would be extremely site specific, determined largely by the stations chosen to represent "background."

- Criteria may be unrealistic and too restrictive since there is no attempt to define a maximum, biologically safe level of contamination.

EPA WATER QUALITY CRITERIA APPROACH

Definition

Contaminant concentrations in interstitial water, rather than in bulk sediment, are measured and compared to EPA water quality criteria.

Methodology

This approach was developed in EPA Region VI as a method of applying the toxicological data base associated with existing water quality criteria to sediments. Interstitial waters were considered to be an extension of the overlying water column and therefore in need of the same level of protection. Existing EPA water quality criteria, either 24-hour average concentration or maximum permissible concentrations for the protection of freshwater aquatic life, were directly applied as sediment quality indicators. Concentrations of dissolved contaminants measured in the interstitial water were then compared to the water quality criteria to determine whether contamination was within permissible limits.

This approach is inherently attractive because of its simplicity, but serious technical questions and methodological difficulties must be considered prior to its application. This approach assumes that EPA water quality criteria, which have been derived in sediment-free bioassays using principally nektonic organisms, will provide adequate protection to infaunal organisms. However, not only are infaunal organisms exposed to contaminants dissolved in the interstitial water, but they ingest sediment particles that typically have contaminant concentrations several orders of magnitude greater than in the interstitial water. If ingestion of contaminated sediment contributes to contaminant uptake, this alone does not discount the EPA water quality criteria approach. However, this approach, and the sediment-water partitioning approach discussed next assume that ingestion of sediment does not increase contaminant uptake above that attainable by absorption from the interstitial water alone.

The potential for contaminant uptake by ingestion resulting in a body burden greater than that attainable entirely from the interstitial water has not been adequately assessed. To date, experimental evidence has been contradictory. In an extensive series of laboratory tests in which midges were exposed to kepone-contaminated water, sediment or food, it was found that the primary route of pollutant uptake to be from interstitial water and/or water at the sediment/water interface. It was suggested that a sediment would be toxic to benthic organisms only if the interstitial water concentration equalled or exceeded a level determined to be harmful in a standard static bioassay. On the other hand, it was found that ingestion of PCB-contaminated sediment by a polychaete can dramatically increase contaminant uptake above that attainable from the interstitial water.

A second point of concern regarding the EPA water quality criteria approach is the necessity of measuring contaminant concentrations in interstitial water. The methodology of interstitial water collection and analysis is not well developed or widely practiced, especially for organic compounds. The primary difficulties are extracting interstitial water from the sediment without altering its chemistry and obtaining a sufficient volume for analysis of organic compounds. In sandy sediments, collecting an adequate volume for analysis is difficult if not impossible.

Advantages

- The EPA water quality criteria approach incorporates the large toxicological data base associated with EPA water quality criteria.

- This approach is applicable to a wide spectrum of sediment contaminants, including metals and organics, since direct measurements of contaminant concentrations are used rather than concentrations calculated on the basis of partitioning coefficients.

Disadvantages

- Sediment criteria cannot be established for those compounds lacking water quality criteria.

- This approach neglects the potential for biota-sediment pollutant transfer independent of uptake from interstitial water.

- Difficulties are associated with both sampling and the analysis of contaminants in interstitial waters.

EQUILIBRIUM PARTITIONING APPROACHES

Definition

Distribution coefficients are used to establish a contaminant concentration in sediment that at equilibrium will yield an acceptable contaminant concentration in another environmental phase, either water or tissue.

Methodology

Equilibrium partitioning approaches rely on the assumption that the distribution of a contaminant in sediment is solely controlled by rapid and continuous exchange between the solid sediment, interstitial and overlying water, and indigenous biota. Under these conditions, the equilibrium concentration of the contaminant in a particular reservoir is a function of its concentration in any other reservoir and an appropriate equilibrium constant. These constants are referred to as partition coefficients, bioconcentration factors, or bioaccumulation factors, depending on whether abiotic or biotic reservoirs are being considered. They are expressed mathematically as:

$$K = \frac{C_i^x}{C_j^x} \qquad (1)$$

where K equals a distribution coefficient at equilibrium and C_i^x and C_j^x the concentration of contaminant x in reservoirs i and j, respectively. Values of K can be derived theoretically or empirically through laboratory or field studies. To determine sediment criteria using an equilibrium partitioning approach, equation (1) is rewritten as:

$$C_s^x = KC_{w/t}^x \qquad (2)$$

where C_s^x equals the criteria concentration in sediment and $C_{w/t}^x$ equals an acceptable contaminant concentration in water or tissue.

Using this equation, known values for K, and maximum allowable values of $C^{x}_{w/t}$ derived from water quality standards or permissible tissue levels, it is possible to calculate sediment criteria that are consistent with these standards.

Sediment-Water Equilibrium Partitioning

Definition

The concentration of a contaminant in sediment is established at a level that ensures that its concentration in the interstitial water does not exceed the EPA water quality criteria.

Methodology

As in the case for the water quality criteria approach, the sediment water equilibrium partitioning approach is based on the premise that existing EPA water quality criteria, when applied to the interstitial water, provide adequate protection to infaunal organisms. Compound-specific partitioning coefficients are then determined, and these may be used in predicting the distribution of the contaminant between sediment and interstitial water as follows:

$$K_D = \frac{C^x_s}{C^x_{iw}} \qquad (3)$$

where K_D is the partition coefficient and C^x_s and C^x_{iw} are the concentrations of contaminant x in the sediment(s) and interstitial water (IW), respectively. The distribution of most contaminants between water and sediment is strongly influenced by the amount of organic carbon in the sediments; sediments with a high organic content having the greatest affinity for contaminants. Thus it is more appropriate to express the partition coefficient in terms of organic content:

$$K_{OC} = \frac{C^x_s}{C^x_{iw}} \times \frac{1}{TOC} = \frac{K_D}{TOC} \qquad (4)$$

where K_{OC} is the organic carbon normalized partition coefficient and TOC is the total organic carbon content of the sediment expressed as a fractional mass on a dry weight basis. Setting the EPA water quality criterion ($C^{x}_{w/cr}$) equal to the interstitial water concentration (C^{x}_{iw}) and the corresponding sediment concentration as the criterion ($C^{x}_{s/cr}$), equation (4) becomes:

$$C^{x}_{s/cr} = C^{x}_{w/cr} \times K_{OC} \times TOC \qquad (5)$$

For organic compounds, K_{OC} values are typically estimated from the octanol-water partition coefficients, K_{OW}. K_{OW} values are available for most compounds and, since they are a measure of a compound's affinity for an organic matrix to serve as effective predictors of a compound's sorptive potential on sediments particles coated with organic matter. A variety of regression equations are available in the literature for estimating K_{OW} from K_{OC}. The most appropriate regression depends largely on the particular compound of concern. The regression used in the original development of the sediment-water partitioning approach was based on 19 priority pollutants and seemed to provide acceptable estimates of K_{OC} for a wide variety of compounds.

Determining of equilibrium partition coefficients for trace metals is much more difficult than for many organic compounds. For many organic compounds, and particularly the base neutral compounds, partitioning can be explained largely on the basis of organic carbon content, with relatively little dependence on other physical/chemical environmental factors. In contrast, while trace metal partitioning is often influenced to some degree by organic content, a wide variety of other physical/chemical factors can be even more influential in determining the distribution of trace metals between sediment and interstitial water. Reduction-oxidation potential and pH are among the most important of these physical/chemical factors. Given the current state of knowledge, it is impossible to precisely quantify the dependence of trace metal partitioning on the many pertinent environmental variables. Quasi-equilibrium coefficients, derived by empirical comparisons of trace metal concentrations in sediment and interstitial water, have been used to estimate sediment criteria from EPA water quality criteria. However, site-specific variation in physical/chemical factors makes the level of uncertainty associated with these estimates considerable, complicating the use of trace metal sediment criteria for regulatory application.

The sediment-water equilibrium partitioning approach to sediment quality criteria was developed in order to make use of the large toxicological data base already incorporated in the EPA water quality criteria. For the 10 trace metals and 10 organic compounds for which EPA water quality criteria for the protection of aquatic life are available the development of sediment criteria is straightforward. However, for most organic chemicals, no water quality criteria are available. Instead EPA criteria documents report only the lowest concentration at which adverse biological effects have been noted. In order to establish sediment criteria for these compounds, it may be possible to use one half of the lowest concentration causing effects as an interim water quality "criterion." This procedure closely parallels the protocol followed in developing water quality criteria in which a Final Acute Value (FAV), designed to protect 95 percent of a diverse group of species is determined, and the criteria is established at one half of the FAV. This represents the only possible approach for many organic compounds, although it is important to recognize that for some compounds the lowest concentration causing adverse effects is based on a very limited toxicological data base, and the derived sediment criteria may be inadequate to protect aquatic life.

Advantages

- The large toxicological data base is incorporated in the EPA water quality criteria and directly used for sediment quality criteria. Sediment quality criteria can be developed for those compounds for which EPA water quality criteria are available.

- The theoretical basis and methodology of the approach are well-defined, facilitating verification and/or refinement on the basis of field and laboratory studies.

Disadvantages

- No sediment criteria can be established for those compounds for which EPA water quality criteria have not been developed.

- The approach does not account for any increase in contaminant burden of biota which may result from ingestion of contaminated sediments above that which is attained simply by absorption from the interstitial/overlying water.

- The assumption of contaminant equilibrium between solid and aqueous phases inherent in the approach may not always hold in natural systems.

- Criteria developed for trace metals have a very high associated uncertainty, making their regulatory application difficult.

Sediment-Biota Equilibrium Partitioning

Definition

A sediment quality criterion is established as the concentration of contaminant in sediment that ensures that it is impossible for an organism at thermodynamic equilibrium with the sediment to attain a contaminant body burden in excess of an established permissible limit.

Methodology

This approach, also known as the thermodynamic equilibrium/bioavailability approach, has been principally advocated by EPA/ERL - Narragansett and the Corps of Engineers. It should be noted that this approach has been suggested for use only for the development of sediment criteria for hydrophobic or neutral organic compounds. Metals, water-soluble organics, or compounds that associate with sediment principally by electrostatic interactions are not considered since they do not satisfy the requirements of the equilibrium partitioning model.

The sediment-biota equilibrium partitioning approach defines a sediment criterion on the basis of a permissible tissue level by the equation:

$$\log SQC = (\log C_t^x - 0.28) + \log TOC \qquad (6)$$

where SQC is the sediment quality criterion;

C_t^x is an acceptable tissue concentration for contaminant x, expressed on a lipid basis;

0.28 is a factor accounting for the relative activities of hydrophobic or neutral compounds in TOC and in lipid and

TOC is the total organic carbon content of the sediment expressed as a fractional mass on a dry weight basis.

This approach has a number of inherent assumptions. First, all organisms are considered to have a similar bioaccumulation potential when contaminant burden is expressed on a lipid basis. In other words, all lipids are considered to have a similar affinity for hydrophobic or neutral organic compounds. Second, the hydrophobic or neutral organic compounds in organisms are considered to be predominantly associated with the lipid fraction. Third, since the activity of hydrophobic or neutral compounds in lipid and TOC are very similar in comparison to the wide differences in activity between either of these organic phases and water, the bioaccumulation potential for these compounds is considered to be compound-independent. The only compound-specific information required is the permissible tissue concentration, since the distribution coefficient of the contaminant between sediment and biota is considered to be a constant.

This approach depends on designating a permissible level of contamination in tissue from which sediment criteria can be developed. At present, the only permissible tissue levels available are those employed by the Food and Drug Administration (FDA), and these criteria are available for only a very few contaminants. In addition, they have been established only for the protection of human health and thus may not provide adequate protection against other environmental impacts. Application of the sediment-biota partitioning approach therefore depends on developing an extensive burden-effect data base in order to establish biologically "safe" levels of contaminants in tissue. The extensive laboratory and/or field testing required to develop this data base would in many respects be similar to developing sediment criteria entirely by the bioassay approach.

Recognizing the current absence of the burden-effect data needed to directly determine acceptable contaminant concentrations in tissue, a method was developed to estimate these levels from water quality criteria. It is assumed that organisms living in an environment in which EPA water quality criteria are not violated, would also have acceptable levels of contaminants in their tissues. Water quality criteria (WQC), and appropriate bioconcentration factors (BCF) can therefore be used to estimate the C_t^x term of equation (6) by:

$$\log C_t^x = \log BCF + \log WQC \tag{7}$$

A variety of equations are available to estimate a bioaccumulation factor for a compound from its octanol-water partition coefficient, one of which is listed below:

$$\log BCF = 0.980 \log K_{OW} - 0.063 \tag{8}$$

Developing sediment criteria using acceptable tissue contaminant levels derived from water quality criteria and bioconcentration factors can be shown to be identical to abiotic partitioning involving only sediment and water and thus does not present a unique approach to developing sediment criteria. Furthermore, the approach requires the quantification of two partitioning processes (water-biota and biota-sediment) and thus increases the opportunity for error.

Advantages

- Permissible tissue contaminant levels developed from burden/effect studies would result in criteria that account for uptake mechanisms involving both interstitial water and ingestion of sediment.

- Provides an impetus for burden effect studies that can increase our understanding of contaminant behavior and bioavailability.

Disadvantages

- Little is known about the variation in bioaccumulation factors with contaminant type, animal species, or lipid composition.

- Few data are available on acceptable tissue levels for contaminants present in natural sediments. The FDA levels may have little relevance to environmental quality.

- Some organic compounds may accumulate in animal tissues in a non-equilibrium manner.

- The full development of this approach would require a very resource-intensive effort.

BIOASSAY APPROACH

Definition

Dose-response-type relationships are developed by holding test organisms in sediments containing a known concentration of contaminant(s) and measuring mortality, sublethal effects or bioconcentration.

Methodology

Sediment bioassays have been employed for many years as a pass/fail test to evaluate the biological impact potential of contaminated sediments. For example, any dredged material proposed for dumping into ocean waters must either meet several exclusionary criteria or be evaluated by a sediment bioassay. Test organisms are held in the sediment of concern for a 10-day period, after which the number of dead organisms are counted. Any statistically significant increase in mortality relative to controls is considered potentially undesirable. Though this procedure is suitable for evaluating the environmental hazard of the contaminated material, its applicability to sediment criteria is limited by the fact that it does not identify the causative agent(s) of the observed biological effect.

Sediment bioassays could potentially be used to develop sediment quality criteria in a manner analogous to the way aqueous bioassays have been used to develop EPA water quality criteria. Clean sediments could be spiked with known amounts of a contaminant in order to derive a dose-response relationship. Such information has been developed for cadmium but is unavailable for other compounds. While bioassays are probably a necessary component in the sediment criteria development process, development of sediment criteria entirely by using bioassays would likely be a long and difficult process. It would be necessary to conduct bioassays on a wide variety of organisms, representing diverse feeding types, and to use many different sediment types exhibiting a range of physical/chemical properties. A number of methodological differences would also have to be resolved since the toxicity of a sediment can be dramatically affected by sample collecting and handling procedures.

Bioassay approaches to sediment criteria are unique in that they provide the only means currently available to empirically address interactions among contaminants that influence overall sediment toxicity. The joint toxicity of mixtures of contaminants may be additive, more than additive (synergistic), or less than additive (antagonistic). Synergistic interactions are of particular concern since biological impacts may be caused by a mixture of contaminants even when each contaminant is below a criterion established on an individual basis. Bioassays can be used in the empirical assessment of joint action, for example by (1) establishing dose-response relationships for particular contaminant mixtures, or (2) as a final test of biological impact potential of a sediment in which all contaminants are below their individual criteria.

Advantages

- Criteria would account for all possible routes of contaminant uptake.

- The simplicity of the approach and its comparability to the procedures followed in deriving EPA water quality criteria would promote public acceptance of the sediment criteria.

Disadvantages

- Appropriate standardized techniques would have to be developed for sediment bioassays with contaminated sediments. Widely accepted methodologies for spiking sediments to a specified level of contamination are particularly lacking.

Summary of Methodologies

Most of the approaches for developing sediment criteria discussed in this report contain hypotheses or assumptions that must be verified before they can be applied. In addition, even those approaches that employ methods that do not require extensive verification (e.g., the bioassay approach) must have standardized techniques and a data base of criteria levels established before implementation. Based on this information, the subcommittee decided that the background approach was the methodology of choice for establishment of interim criteria. As national sediment criteria become available, they may be substituted for the interim criteria and adopted as permanent dredge disposal guidelines if deemed acceptable by the agency.

REGION V STATES DREDGE CRITERIA REVIEW

In addition to review of work at the national level the subcommittee felt that a review of what other states are doing in this area would be worthwhile. The summary below briefly lists the factors other Lake Michigan states consider in the evaluation of dredge projects.

Illinois Environmental Protection Agency (IEPA)

Between 1974 and 1980 the IEPA analyzed over 800 sediment samples from 550 stream sites throughout the state and over 270 sediment samples from 63 Illinois lakes.

Sediment data was analyzed to establish background levels and sediment chemistry characteristics at varying distances downstream from municipal wastewater treatment facilities, and sampling locations impacted by various point and non-point pollutional sources.

Although sediment sampling was biased toward urban and point discharges, a sufficiently large sample of background sites was available for most constituents so that "background levels" could be established. The designation of background was somewhat qualified since some sites were subject to agricultural runoff.

IEPA Project Review of dredging proposals is based on the "type" of project, disposal location (deep water...established sites two-three miles offshore, CDF's, quarry, or upland) and sediment types (particle size). The evaluation of projects and application of the classification categories is done on a case-by-case basis. There is not a rigid format.

Michigan Department of Natural Resources.

The State of Michigan encourages the beneficial reuse of dredge spoil material and beach nourishment where erosion has occurred. If dredge material is identified as uncontaminated and no other feasible disposal alternatives are available, in-water disposal may be considered. "Guidelines for the Pollutional Classification of Great Lakes Harbor Sediments" are usually used as criteria for project review. The state has an eight-member project review committee which evaluates projects on a case-by-case basis. This approach allows some discretion in regulating dredge projects. Certain value judgements are allowed based on project type and available data.

The International Joint Commission (IJC) Guidelines for Evaluation of Great Lakes Dredging Projects is used by the review committee in considering in-water disposal. Factors to consider regarding the disposal site are:

1. Chemical and physical characteristics of the substrate at the disposal site should not be degraded.

2. The site should be removed from the vicinity of municipal and private water supply intakes.

3. The sites should be removed from a recognized commercial or recreational fishing ground and from spawning, nursery, rearing, food supply and migration areas on which fish depend directly or indirectly to carry out their life processes.

4. The site should be in a non-erosive section of the lake to prevent spread of the material to areas outside the disposal area.

5. The site should be removed from areas of recreational and aesthetic values.

In addition, like-on-like (sand on sand) or gravel on sand is preferred. EPA Sludge Disposal Guidelines are used for upland disposal. IJC Guidelines are used for analytical sampling.

<u>Minnesota Pollution Control Agency</u>

The State of Minnesota generally opposes wetland and in-water disposal of dredged material. This type of disposal may be considered for a project which can be thoroughly justified and can demonstrate benefits that outweigh potential negative impact. There is not a set of standards for confined disposal facilities versus in-water disposal. All proposals are reviewed on a case-by-case basis. The State's Secondary Treatment Standards are utilized in determining disposal alternative feasibility. It should be noted that no toxic discharges are permitted. The requirements of secondary treatment are used in addition to any requirement imposed on a discharge by the Clean Water Act, Title 33, Parts 1251, and its implementing regulations. In the case of a conflict between the two regulations, the more stringent requirement prevails.

In cases where the Minnesota Pollution Control Agency determines that the strict use of the secondary treatment standards may not be appropriate or applicable, a variance with specific conditions is issued for the dredge disposal project. This approach further fosters a case-by-case review with discretionary capabilities rather than a rigid format.

Indiana

In Indiana, the Natural Resources Commission reviews dredge projects. Specific guidelines are not coded, and U.S. EPA Standards are used for project evaluation.

Ohio

The Ohio EPA reviews dredging projects case-by-case on its own merit in a site-specific review. There is no specific criteria outlined.

INTERIM CRITERIA AND GUIDANCE CRITERIA FOR IN-WATER DISPOSAL

The interim criteria listed below were established using the previously discussed background approach. Background data utilized came from a variety of sources including; metals concentrations from recent and greater than 200 year old Lake Michigan sediments, bluff material from Lake Michigan shorelines, and average concentrations of selected metals and organics in surficial sediment sampled from all the Great Lakes. It is highly recommended that these criteria remain flexible and subject to change as additional background data becomes available.

When establishing these criteria the subcommittee made every attempt to be consistent with present Department policy on the discharge of chemical contaminants in toxic amounts. For example, for in-water disposal of dredge material no detectable concentrations of certain constituents, such as PCB, can be present.

TABLE 1

Ranges used to classify sediments from Great Lakes Harbors for possible disposal options. All values in ug/g dry weight unless noted.

Organics	In Water
PCB	< .05 *
Total 2,3,7,8 TCDD	< 1.0 pg/g *
Total 2,3,7,8 TCDF	< 1.0 pg/g *
Metals	
Copper	≤ 100
Arsenic	≤ 10
Lead	≤ 50
Nickel	≤ 100
Barium	≤ 500
Chromium	≤ 100
Mercury	≤ 0.1
Zinc	≤ 100
Cadmium	≤ 1.0
Selenium	≤ 1.0

Organics	In Water
Pesticides	
Aldrin	< .01
Dieldrin	< .01
Chlordane	< .01
Endrin	< .05
Heptachlor	< .05
Lindane	< .05
Toxaphene	< .05
DDT	< .01
Other	
Oil & Grease	< 1,000
**NO_2	
NO_3	
NH_3-N	
TKN	

Total organic carbon (TOC) analysis will be required on all sediment samples analyzed. The subcommittee feels that it is now well established that the percent organic carbon of a sediment sample is directly related to adsorption and inversely related to contaminant bioavailability. This is especially true for base-neutral organics.

* These are desired levels of quantitation, however, if analytically unachievable due to sample interreferences, an alternate level of detection and quantitation may be accepted after consultation with the Department.

**The nitrogen series is required when doing bulk chemical analysis because it is a required test by solid waste rules.

Guidance Criteria for In-Water Disposal

- If any pollutant, or group of pollutants, of concern is found in concentrations greater than 125% of the interim criteria for that pollutant, in-water disposal will not be allowed.

- If three or more pollutants are found in concentrations greater than 110% of the interim criteria for those pollutants, in-water disposal will not be allowed.

- If one or two pollutants are found in concentrations within the range of 110-125% of the interim criteria for those same pollutants, in-water disposal will be determined on a case-by-case basis.

- If all pollutants are found at concentrations of 110% or less than the interim criteria for those same pollutants, in-water disposal may be allowed.

- For on the beach disposal the particle size of the dredged material must meet the following criteria: the average percent of spoil material finer than .074 mm must be within 10-15 percent points of average disposal site material finer than .074 mm.

THE ELUTRIATE TEST

Background

The elutriate test is intended to represent the dissolved immediately releasable fraction of the various chemical constituents in dredged material. It was developed and is used for determining the potential for contaminant release (quality of effluent) from disposal areas during hydraulic dredging operations.

The standard elutriate test consists of mixing one part of sediment from the dredging site with four parts of water from the dredging site, shaking vigorously for 30 minutes then allow to settle for one hour. Centrifugation and filtration follow. The resulting filtered water is called the elutriate. A sample of the elutriate is analyzed for dissolved and total concentrations of contaminants of interest.

The modified elutriate test consists of mixing sediment and water from the dredging site into a slurry with the concentration of solids approximately equal to that expected in the disposal site influent. The slurry is placed in

4 liter cylinders and aerated for one hour to ensure oxidizing conditions. The aerated slurry is allowed to settle for a time period equal to the expected field mean retention time of the disposal area up to a maximum of 24 hours. A sample of the supernatant water is extracted from the cylinder and analyzed for total suspended solids and dissolved and total concentrations of contaminants of interest. The fraction of contaminants associated with the suspended solids is calculated.

The elutriate concentrations, the dissolved concentrations at the proposed disposal site and applicable water quality standards are used together with physical characteristics of the disposal site and disposal method to calculate the mixing zone theoretically needed to dilute the dredged material discharge to an acceptable level or to determine whether the discharge will meet the applicable standards at the perimeter of the authorized disposal site.

Some questions have been raised by regulatory agencies and scientists as to the adequacy of the elutriate test in characterizing dredged materials with regard to potential release of contaminants upon in-water disposal because it reflects only immediate release to the water column under aerobic and near neutral pH conditions. A number of agencies and scientists have all but eliminated elutriate testing because it is rarely acutely toxic and after consideration of initial mixing, usually contains low to nondetectable levels of contaminants. Because of this, the subcommittee recommends that elutriate testing not be used or required on the initial evaluation of dredge material.

Other liquid phase (leaching) tests do have a benefit in evaluation of confined disposal options for dredge material. The most common liquid phase tests are discussed below.

REVIEW OF WASTE LEACHING TECHNIQUES

As stated in the objectives, the subcommittee thought it useful to review waste leaching techniques and determine their usefulness in evaluation of disposal options for dredge material.

Six procedures were reviewed and are listed below.

1. ASTM D3987-81 Standard Test Method for Shake Extraction of Solid Waste with Water,
2. U.W. Standard Leach Test,
3. American Foundrymen's Society (AFS) Leach Test,
4. COE's Leach Test,
5. Warner Method,
6. EPA's Toxic Extraction Procedure.

The first five tests are used to assess the mobility of a specific parameter or group of parameters (organic or inorganic) identified as present within the material to be characterized and possessing the potential to impact the environment if released in significant amounts.

Prior to performing any extractions, standard procedure requires that the material be chemically characterized by performing a "bulk chemical analysis". This provides the lab analyst and the reviewer with the total concentration present, usually reported in mg/kg dry weight, for each element or compound quantified.

Having characterized the material the lab analyst can proceed to the next phase, the extraction process, by subjecting the sediment to one of the five water extraction procedures listed above (1-5) or the acid extraction procedure. The acid extraction will be discussed separately, because rather than assess mobility it is used to characterize the waste as hazardous or nonhazardous.

The mechanics, sample size, solid/liquid ratio, etc., for the first five procedures (See Table 2) indicates that they all use water as the extraction medium and with the exception of ASTM's method, a sample size of approximately 100 g.

The Warner Method uses a closed vessel instead of a shake flask when performing the extraction process. Closed vessel extraction is primarily used where there are known or suspected levels of purgeable and semi-volatile organic pollutants. The other procedures are shake flask reactors where if testing for purgeable or semi-volatile organic pollutants they would likely be lost as a result of the samples agitation and direct contact with the atmosphere.

Another major difference in leaching technique noted on the summary table, is that the U.W. and AFS procedures require multiple sample elutions. With the exception of the variable dilution ratio (see Table 2) the UW Procedure R and the AFS test are the same as both procedures attempt to quantify the maximum amount of the constituent under consideration which can be released from a particular sample. Of particular importance is the effect that the dilution ratio has on the amount of mass extracted. A solution with a low liquid to solids ratio reaches saturation quickly and is therefore unable to extract that portion which would have solubilized had there been sufficient eluent available. This phenomenon is of more concern with single elution tests as results from multiple elutions can be evaluated by plotting the total amount leached from each elution versus the amount of liquid used in the leaching process. If the curve continues to rise with each elution (AFS and UW Procedure R) then one can conclude that more would have solubilized had the solution not reached saturation. It also indicates that that particular constituent is quite mobile and that it needs to be evaluated as to its potential to impact the environment. On the other hand, if the curve quickly levels off after the first elution (AFS and UW Procedure R) then one could alternately conclude that the readily leached portion had been eluted and that subsequent release would be long-term and likely a function of chemical or other processes which might occur through time.

The other U.W. test, Procedure C, uses water from the previous elution with a new sample. This procedure is designed to produce the maximum concentration which might occur in a leachate. This information along with volume and production rate is particularly helpful to WWTP operators as it may influence how leachate would be introduced into the WWTP for processing.

The ASTM, COE's and Warner Method water extraction procedures require one elution and therefore do not provide as accurate an estimate for maximum release or concentration nor do they allow extract projections (as discussed above) as to the amount which can be expected to quickly elute as a result of simple flushing actions be it from contact with rain water infiltrating a landfill or lake water seeping through sediment confined within a CDF.

TABLE 2

SUMMARY OF LEACH TEST PROCEDURE

Procedure	Leaching Medium	Sample Size (g)	Solid to Liquid Ratio	Time (Hrs)	Number of Elutions
ASTM Method D3987-81	Water	700	1:4	48	1
UW Standard Leach Test					
a) Procedure R	Water	100	1:10	24	a
			1:10	24	
			1:10	24	
b) Procedure C	Water	100	1:10	24	b
		100	1:7.5	24	
		100	1:5	24	
AFS Leach Test	Water	100	1:4	72-144	c
COE's Leach Test	Water	100	1:4	1 1/2	1
Warner Method	Water	75	1:20	20	1
EPA Toxic Extraction Procedure	Water & Acid	100	1:20	24	1[d]

a) U.W. Procedure R requires three elutions of the same sample, at the dilution ratios noted. Each elution is performed with fresh water.

b) U.W. Procedure C requires three different samples to be eluted with the same water but at different solid to liquid ratios.

c) AFS Leach Test requires three elutions of the same sample. Each elution is performed with fresh water.

d) The extraction medium for the EPA Toxic Extraction procedure is comprised of 16 parts water and no more than 4 parts mild acid to provide a maximum liquid to solid ratio of 20:1. The pH is adjusted to between 4.8 to 5.2. At the end of the 24 hour extraction period deionized water will be added to the extractor in an amount not to exceed four times the weight of the sample minus the amount of acid added during the extraction.

Once the leach procedure has been selected and the tests performed there are numerous methods for interpreting the results. One method requires converting the elutriate concentrations (mg/L) to amount released (mg/kg dry weight). This provides the reviewer with an immediate indication as to the percent of the total amount identified in the bulk analysis which has mobilized. Depending on the extraction process used, UW, AFS or one of the other water extraction procedures, plots can be developed to evaluate whether maximum release has occurred or if specific constituents will continue to elute with each infiltration event. Once a series of reviews have been performed and familiarity with a particular waste established one can compare past/future results as a means of assessing the potential for impacts associated with the amount released. Review of amount released (elutriate concentration) to lake water concentrations and drinking water standards can also be used to compliment the above analysis.

The last test, EPA's Toxic Extraction Procedure, is separate from the above as its primary purpose is to classify a material as hazardous or nonhazardous. The EPA procedure requires the sample to be extracted in a medium comprised of deionized water and mild acetic acid to achieve a pH of 4.8 to 5.2. Elutriate concentrations are then compared to limits developed by EPA which have been set at 100 times the primary drinking water standards. Exceedance of those limits requires disposal within a facility approved to receive hazardous waste.

Based on this review and conversations with agencies presently performing these types of tests the subcommittee feels that these tests will not be required when determining applicability of dredge sediment for unconfined in-water disposal. The proposed bioassay tests will answer the same questions and others in a more efficient manner. However, we do recommend that these types of leaching tests be used to develop site design criteria for sediment which has been determined to be suitable only for in-water confined disposal or some form of upland disposal.

PARTICLE SIZE ANALYSIS DISCUSSION

Particle size analysis should be required for evaluation of on the beach in-water dredge material disposal requests. Dredge material should have particle size characteristics similar to material found at the disposal site.

In order to ensure that dredge material is compatible with disposal site material, representative samples of disposal site material and proposed dredge material should be analyzed for particle size distribution according to procedures described in ASTM standard D422 or some similar Department-approved method.

In order to determine material compatibility, the most significant characteristic is generally the relative proportion of sand vs. silt and clay. To provide a basis of comparison the percent of material finer than .074 mm (passing a No. 200 sieve) should be determined for both dredge material and disposal site material. Dredge site material should be core sampled to project depth plus 1 foot and homogenized for particle size analysis. Beach material should be cored to a depth of 3 feet and mixed for analysis.

The average percent of dredge material finer than .074 mm must be within 10-15 percentage points of average disposal site material finer than .074 mm to be considered compatible and acceptable for in-water disposal.

The 10-15 percentage point range is determined by adding 10 and 15 to the percent of disposal site material finer than .074 mm. If this value is greater than or equal to the percent of dredge material finer than 0.74 mm the dredge material particle size will be considered compatible with disposal site material.

For example: Beach material with 2 percent finer than .074 mm.

Dredge material with 11 percent finer than .074 mm.

2 + 10 = 12 , 2 + 15 = 17. The range is then 12 - 17. Because the dredge material value is 11 the material is suitable for in-water disposal based on grain size.

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APPENDIX A

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Carroll D. Besadny
Secretary

BOX 7921
MADISON, WISCONSIN 53707

September 26, 1984

File Ref: 8250

Mr. Louis Kowalski
U.S Dept. of the Army
Corps of Engineers
Planning Division
1135 U.S. Post Office
St. Paul, MN 55101

Dear Mr. Kowalski:

Attached is a summary of the Scope of Work for Management Alternatives for Contaminated Sediment. On June 14, 1984 the State of Wisconsin requested this study as a top priority for FY '85 under Section 22 of the Water Resources Development Act of 1974.

A three-phased approach will: (1) evaluate the toxicity of inplace and resuspended sediment via bioassay techniques; (2) evaluate management alternatives, including (a) leave sediments until buried by clean sediments, (b) remove sediments via dredging; and (3) define the movement of sediments.

Mr. Jack Sullivan, Bureau of Water Resources Management, Surface Water Standards and Monitoring Section will work with your staff to refine this scope of work and to develop a time table and the cost estimate associated with the attached tasks. A meeting on Wednesday, October 10 at 1:00 p.m. in Room 217 of GEF II , here in Madison, will provide an opportunity for DNR staff to review this proposal with your representatives. I would appreciate it if you would include Mr. T.M. Dillon or Dick Petticord, Vicksburg; Mr. Frank Snitz, Detroit; and Mr. Dick Beatty, St. Paul Districts in this meeting. They have all been working together with DNR staff on the Sheboygan and Mississippi Rivers as part of the state's effort to deal with this issue.

If you have any questions concerning this study, please contact me, at the above address, or call me at 608/266-2576.

Sincerely,
Bureau of Water Resources Management

Rahim Oghalai

Rahim Oghalai
Water Resources Planning and Policy Section

RO:djc

Enc.

cc: Jack Sullivan - WRM/2
M. Llewelyn - WRM/2
Scott Hausmann - WRZ/5
Mary Ann Heidemann - SW/3
Frank Snitz - COE/Detroit
Dick Beatty - COE/St. Paul
D. Schuettpelz - WRM/2
Russell Dunst - TS/2
Paul LaLiberte - WC Dist., Eau Claire
Joe Wanielista - COE/Detroit
T. Dillon - COE/Vicksburg
Dick Petticord - COE/Vicksburg

I. Project Description

In the last few years it has become apparent that existing techniques for evaluating the toxicity of dredge spoils fall woefully short of providing decision makers with adequate data to choose dredging techniques or ecologically sound disposal options. Furthermore, certain data on sediment pollution exists in Corp of Engineers files, but is not easily accessed by various user groups because of its present format.

The Wisconsin Department of Natural Resources feels that these shortcomings can be overcome through application of Section 22 funded research. A dual approach with separate objectives for each approach is proposed. Year one (phase one) would involve two work efforts. First, a literature and current research review of biological screening techniques that can be used to evaluate the toxicity of sediments. This review should emphasize biomonitoring techniques, however, the review should not be limited to this type of testing. At the same time, and in parallel with the desk top biomonitoring review, certain existing bulk sediment analysis data should be published in report format and made more easily available to various user groups. The specific data targeted for publication is the bulk sediment analysis data generated by the Corp of Engineers, St. Paul District, between 1974-82 from Pools (1-10) of the Mississippi River. It is anticipated that this secondary effort could be completed in one year. (See Figure 1).

Year two (phase two) would involve the testing of the best biomonitoring test methods by various laboratories. Following completion of the testing, an evaluation of the methods by the COE and Wisconsin Department of Natural Resources (WDNR) would be carried out. After the final method is chosen, year three (phase three) can begin. This phase will involve rigorous testing of the chosen method. A wide variety of sediments qualities should be run to access the ability of the test for widespread application.

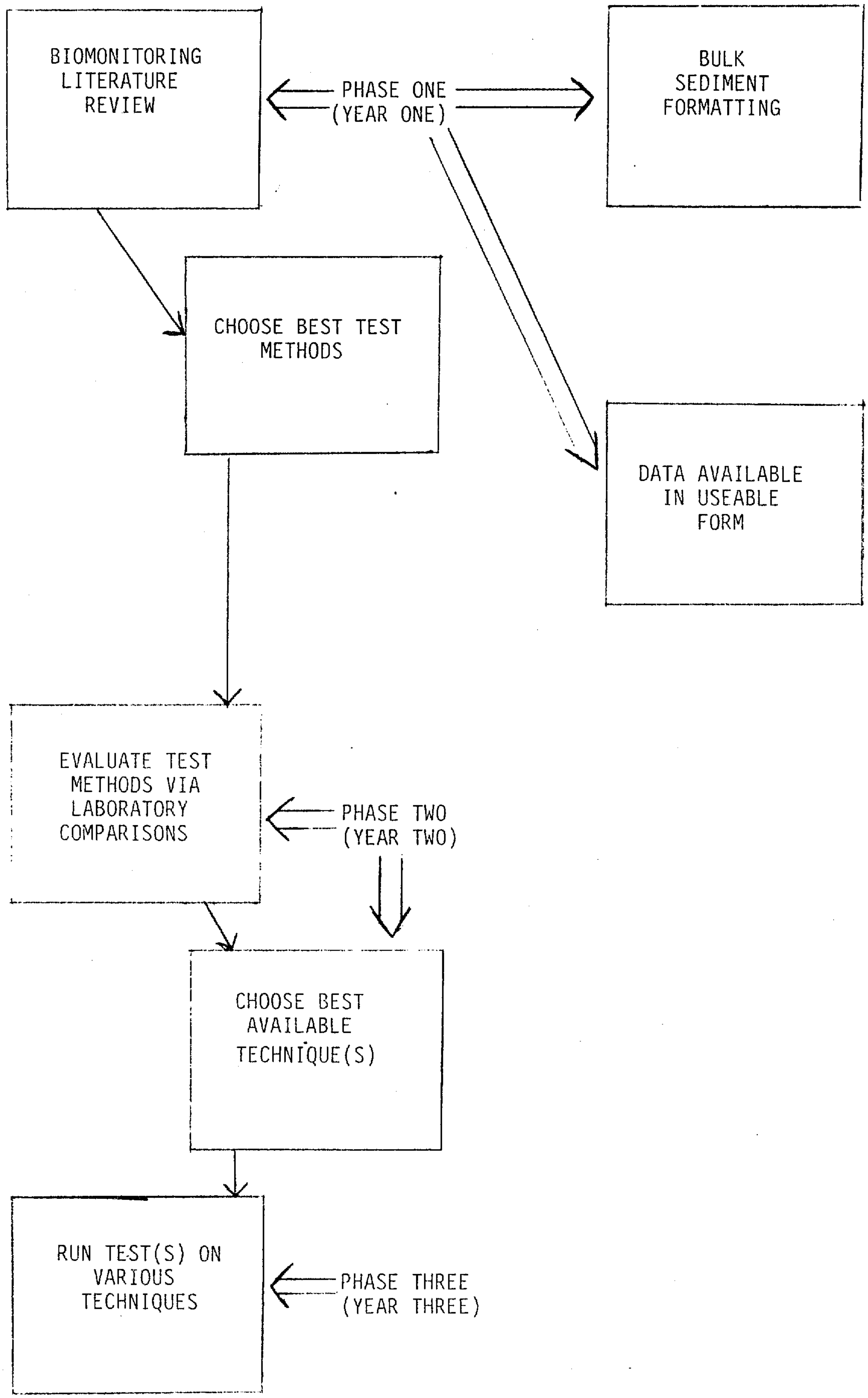

FIGURE 1

FLOW CHART OF PROPOSED WORK SCHEDULE

Objectives

Phase 1 (Year 1) (Task 1)

- To evaluate all available sediment biomonitoring techniques.

- Through joint review select best test methods for laboratory and/or field evaluation.

Phase 1 (Year 1) (Task 2)

- Make available to all user groups bulk sediment data generated by the COE for pools (1-10) of the Mississippi River.

- Use this data to set monitoring priorities for the Mississippi River.

- Complete this task in year one.

Phase 2 (Year 2)

- Evaluate tests selected for utility to assess sediment toxicity and ease of use for decision making.

- Select the best biological method available for further testing.

Phase 3 (Year 3)

- Exhaustively test this procedure on a wide range of sediment types and of varying quality.

- Adopt test procedure as standard protocol to be run for every proposed sediment dredging project.

5140R

20 Nov 84

Preliminary Scope of Work/Discussion Document

Submitted to

U.S. Army Engineer District, St. Paul

by

Environmental Laboratory

U.S. Army Engineer Waterway Experiment Station

Vicksburg, Mississippi

Workshop to Evaluate Sediment Bioassessment Techniques

I. Background: Recently the Wisconsin Department of Natural Resources (DNR) formally requested assistance from the U. S. Army Engineer District, St. Paul (hereafter referred to as "District") in planning management alternatives for contaminated sediments under Section 22 of the Water Resources Development Act of 1974 (attachment 1). On 10 Oct 84, a meeting was held to discuss how to proceed with the work proposed by the DNR (attachment 2). At that meeting, the Environmental Laboratory (EL) of the U. S. Army Engineer Waterways Experiment Station (WES) was identified as the entity responsible for conducting a workshop to accomplish the objective of evaluating sediment bioassessment techniques (see task 1, year 1, attachment 1). This preliminary scope of work describes the conduct of such a workshop. It should be clear that although the DNR plan extends over 3 years, the work described herein is restricted solely to FY 85.

II. Approach: The EL will work with the DNR, through the District, to insure the needs of all parties will be addressed. The DNR in conjunction with the District, will provide the EL with the information necessary to clearly define the scope of the workshop and to brief, in writing, potential workshop participants. The EL will develop a list of potential workshop participants agreeable to both DNR and the District. The technical participants will be selected on the basis of scientific credibility and their experience with using bioassessment techniques in the regulatory evaluation of sediments. These participants will be contacted by the EL who will remain their primary point of contact before, during and after the workshop. Participants will be requested to provide to the EL prior to the workshop a selected number of bioassessment techniques/approaches appropriate for the regulatory evaluation of sediments prior to dredging. They will also be requested to bring with them any and all literature describing advantages and limitations of the techniques they have identified.

The workshop will be conducted at the EL during one week in February 1984. All logistical arrangement will be coordinated through the EL. In addition to the technical workshop participants, representatives from the DNR, the District, and the EL will be present. The DNR and District participants will be available throughout the workshop to provide input as to the regulatory utility of techniques and approaches. Since the U. S. Army Engineer District, Detroit, will be involved in the implementation phase (see Phase 3, Year 3, attachment 1), they will be invited to the workshop. Discussion of potentially useful bioassessment techniques will be primarily limited to those suggested by the participants. It is envisioned that discussions may well range into planned outyear activities (see attachment 1). The EL will insure that these discussions will be limited to that which is germane to the objective of the workshop. Near the end of the workshop, the EL will request workshop participants to prioritize the techniques which were discussed and give a rationale for their ranking.

The EL will record minutes of the workshop.

III. Product: Following the workshop, the EL will prepare a proceedings of the workshop. This manuscript will not be a verbatim transcript but rather a detailed summary. It will contain recommendations developed at the workshop which will be useful to the District in fulfilling its Section 22 obligations to DNR. It will also contain the list of references supplied by the workshop participants as well as any other published or unpublished works deemed appropriate by the EL. The document will be published as an EL Miscellaneous Paper prepared for the District. Unless specifically authorized by the District and

DNR, this report will not contain workshop discussions concerning DNR's three year plan unless those discussions are directly relevant to the purpose of the workshop. Publication costs to produce this document will be the responsibility of the EL.

IV. Schedule:

Date	Activity
Dec 84	Potential workshop participants identified and contacted
Jan 84	Final selection of participants
Feb 85	Conduct the workshop.
Mar 85	Prepare workshop proceedings.
30 April 85	Draft report due to the District
31 May 85	Comments on draft of proceedings due to the EL.
30 June 85	Final report due to the District.

V. Cost:

Workshop* - (Including travel, per diem, consulting fees of technical participants as well as logistical costs at WES)	$12,000
One man - month - EL Senior Scientist	6,000
One man - month - EL Technician	4,200
Publication of Workshop Proceedings	4,600
One man - trip: Vicksburg to Madison/St. Paul	1,000
	27,800

*Assumes 12 technical workshop participants

MAY 0 1985

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Carroll D. Besadny
Secretary

BOX 7921
MADISON, WISCONSIN 53707

May 2, 1985

IN REPLY REFER TO:

Mr. Charles Crist, Chief
Planning Division
Department of the Army
St. Paul District Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, MN 55101

Dear Mr. Crist:

This is in response to your recent letter asking Wisconsin's programs for FY 86 and 87 under Section 22. I request that Section 22 programs continue for current projects in the following priorities.

1. Management alternatives for contaminated sediment, $60,000

   During the current year the Wisconsin DNR and your agency, through its Environmental Laboratory Waterways Experiment Station, conducted a workshop in the Planning Management Alternatives for Contaminated Sediment on April 16-18, 1985. Based on the recommendations of the experts at this workshop the phase II will: (1) evaluate the toxicity of inplace and resuspended sediment via bioassay techniques; (2) evaluate management alternatives, including (a) leave sediments until buried by clean sediment, (b) remove sediments via dredging; and (3) define the movement of sediments.

2. Projection of water resources of the Wisconsin Great Lakes communities, $20,000

   On February 11, 1985 the Governors of the eight Great Lakes states and two Canadian provinces agreed to pursue a development and maintenance of a common base data and information regarding the use and management of basin water resources and to develop a Great Lakes basin water resources management program. In addition, the Wisconsin Department of Natural Resources has been developing statewide water supply conservation programs for the past three years. One of the primary requirements of these two programs is projection of current and future water use for municipal and industrial needs.

This study will: (1) Evaluate the existing data for communities within the Lake Michigan and Lake Superior portions of Wisconsin, (2) Use MAIN II model to forecast the water need for every five year interval in the next 20 years. This model was modified by the U.S. Army COE, St. Paul District, at the request of the Wisconsin DNR in 1984, (3) Recommend demand or supply management activities most appropriate for each community.

This project will help Wisconsin meet a significant portion of its commitment to the Great Lakes Charter.

Duration: One year

3. Wetland evaluation procedures manual. $4,000

The final document from the Wetland Evaluation Methodology is expected to be completed by October 1, 1985. The requested FY 86 budget is for editing, publishing and software development.

Each of these projects are a part of larger ongoing programs in Wisconsin using a special expertise of the Corps of Engineers. If there are additional funds above the $84,000 requested for FY 86, they will be expended according to the priorities sent for FY 85. I will meet with your staff to detail the scope of these proposals as soon as FY 86 funding is known.

Sincerely,

Rahim Oghalai

Rahim Oghalai
Bureau of Water Resources Management

RO:ms:5594T

cc: Bruce Baker - WR/2
John Sullivan - WR/2
Dale Simon - WZ/6

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
1135 U. S. POST OFFICE & CUSTOM HOUSE
ST. PAUL, MINNESOTA 55101-1479

REPLY TO
ATTENTION OF:

July 10, 1985

Planning
Flood Plain Management
and Small Projects

Mr. Rahim Oghalai
Interstate Planning and Coordination
Wisconsin Department of Natural Resources
Box 7921
Madison, Wisconsin 53707

Dear Mr. Oghalai:

Enclosed are 25 copies of the draft report prepared by the Waterways Experiment Station (WES) on the proceedings of the April 1985 workshop on contaminated sediments.

Please distribute the copies within your department and request Mr. John Sullivan to send one copy to each of the workshop participants. Comments on the draft report should be sent to your office, and the summary comments should be forwarded to the St. Paul District by July 31, 1985. We will combine these comments with Corps of Engineers comments from the Detroit District, the North Central Division, and our own district office and forward them to WES. WES will then prepare the final report, which will include an appendix of the letters of comment.

Thank you.

Sincerely,

for Louis Kowalski
Chief, Planning Division

Encl (25 copies)

CORRESPONDENCE / MEMORANDUM

STATE OF WISCONSIN

DATE: September 17, 1985 FILE REF: 8250

TO: Mike Llewelyn -WR/2

FROM: Rahim Oghalai - WR/2 RO

SUBJECT: Management Alternatives for Contaminated Sediment

On September 11, 1985 the U.S. Army Corps of Engineers representatives Tom Dillon and Stan Kummer met with John Sullivan and me to discuss the progress report and develop a plan of the study of the next phase. The purpose of this study is to evaluate toxicity of sediments and management alternatives including the removal or handling in place.

A workshop was conducted in April 1985 with 10 participants and staff from Waterways Experiment Station (WES), WDNR and St. Paul District Corps of Engineers. WES provided with a draft report of workshop proceedings for review. The comments received were generally supportive of the study and proceedings from the workshop. Jack Sullivan is awaiting comments from 1 or 2 more participants before forwarding them to Tom Dillon.

Phase I will include finalizing the proceedings based on comments received. Tom Dillon from Corps will attempt to get the final report done by the end of October, 1985.

Phase II work will be an evaluation of the two selected methodologies, Tier II - Acute Lethality and Tier III - Live Cycle Test, for both possible testing programs of sediment for open water disposal in fresh-water environments. The intent will be to determine the best testing method of those applied under each tier with emphasis given to their working utility and regulatory applicability.

Tom Dillon will prepare the scope of work (2 pages), with input from Jack Sullivan as needed, outlining capability of WES to perform the intended task. Jack Sullivan will meet with Ken Murdock from U.S. Army Corps of Engineers, Chicago to explain the study concept with emphasis on the Great Lakes basin and invite Mr. Murdock to the next planning meeting for Phase II, fiscal year 1986. The purpose of the meeting of Jack Sullivan and Ken Murdock is to discuss the possibility of relaxing the Section 22 guidelines so the Corps of Engineers can contract with an independent laboratory to conduct those testes where Corps of Engineers lack in-house capability.

The next meeting for a broader review of the scope of the study is planned for November 1, 1985.

RO:jmc/7626Y
cc: Bruce Baker - WR/2
Duane Schuettpelz - WR/2
Jack Sullivan - WR/2
Stan Kummer - COE
Tom Dillon - COE